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Research Article

Cardiorespiratory responses to moderate exercise and determination of aerobic power in first year medical students

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ABSTRACT

Background: Cardiovascular and metabolic disorder has become common in individuals leading a sedentary life. Exercise stress tests are carried out as part of the investigations for determining the individual fitness level. Aerobic power or VO_{2max} which involves a full functional support from cardio respiratory and metabolic pathways is an appropriate test to study cardio pulmonary fitness. The main objective of the study is to find out the normal cardiopulmonary responses to exercise and their aerobic power among untrained 1st year medical students by Astrand 6 minute cycle test.
Methods: All participants who were not undergone any physical training was taken for the study. Students with history of any respiratory or cardiovascular disorders, any lower limb surgery, smoking and drinking alcohol were excluded. Cardiorespiratory changes associated with exercise were studied using bicycle ergometer. VO_{2max} was determined from the heart rate noted at the end of 6 minutes cycling by using Astrand-Rhyming nomogram.
Results: Heart rate, systolic blood pressure and respiratory rate increased with exercise, while diastolic pressure recorded a fall. VO_{2max} in male students mean 2.973±0.245, in female students mean 2.665±0.305. The VO_{2max} is the best physiological indicator of a person's capacity to continue the severe physical work. From this we can set a norm in assessing physical fitness and the test can be used as screening measures before joining in a job or sports training.
Conclusions: Aerobic power or VO_{2max} or physical work capacity which involves a full functional support from cardiorespiratory and metabolic pathways is an appropriate test to study cardiopulmonary fitness. Implication: Astrand 6 minutes cycle test can be used for screening measures before joining in a job or sports training where physical fitness is needed.

Key words: Bicycle ergometer, Astrand-Rhyming nomogram, VO_{2max}

INTRODUCTION

Physical exercise has gained prime importance in public life for its enormous health benefits. Cardio vascular and metabolic disease has become common in individuals leading a sedentary life. Practice of regular exercise not only prevents the occurrence of diseases in the community but also halts their progress and decreases their intensity, and sometimes also brings total cure from the disease.[1] Exercise stress tests are carried out as part of the investigations for determining the individual fitness level. Aerobic power or VO_{2max} or physical work capacity which involves a full functional support from cardio respiratory and metabolic pathways is an appropriate test to study cardio pulmonary fitness. The Bicycle ergometer and treadmill are the most commonly used dynamic exercise devices.[1] The advantage of the Bicycle ergometor are it is cheaper, takes up less space and makes

less noise. Upper body motion is lessened that making blood pressure and E.C.G. recordings easier. By doing this study we can set a norm in assessing the physical fitness.

Aim

The aim of the study was to find out the normal cardiopulmonary responses to exercise and their aerobic power among untrained 1st year medical students by Astrand 6 minute cycle test.

METHODS

The present study was designed to be an experimental study conducted in the department of physiology, Rajah Muthiah Medical College, Annamalai University, Annamalai Nagar, Chidambaram, Tamilnadu, India. Students volunteers from Rajah Muthiah Medical College belong to the age group of 17 to 18 years, who were not undergone any physical training were taken for the study. 11 males and 19 females' students were selected after detailed history and physical examination. The students were asked to report at the department of physiology by 9.00 a.m. Subjects were explained the whole procedure in detail and were motivated prior to the start of exercise. They were told to report immediately if they felt any discomfort, fatigue or dizziness.

Inclusion criteria

Healthy students

Exclusion criteria

Alcoholics, smokers, students with any respiratory, cardiovascular disorders and lower limb surgery were excluded from the study.

Bicycle ergometer as instrument

Cardiorespiratory changes associated with exercise were studied using bicycle ergometer (Model-V_{max} 7380 magnetic recumbent bike) available in the physiology department of Rajah Muthiah Medical College, Annamalai University, Chidambaram, India. The instrument is equipped with a programmable computer to help to track the progress and motivate the subject to reach the fitness goal. The computer provides different programmes to match the subject's fitness goals

Anthropometric measurements

Height was measured in centimeters while standing erect. Reading was taken nearest to 1cm by using inch tape. Weight was recorded in kilograms by using a locally made calibrated electronic weighing scale, accuracy±0.01kg and weighing machine was approximately calibrated from time to time. Subjects rested in supine position for 15 minutes before the start of exercise. The parameters namely pulse rate was examined by palpatory method, blood pressure, with a mercury sphygmomanometer and respiratory rate visually during rest. Cycle ergometer was arranged with correct handlebar and seat adjustments. The loading wattage 125 was selected for male and 100 for female. Subjects were asked to pedal at 60 rpm for 6 minutes. During cycling, pulse rate should be steady state between 130-160 beats per minute. If the subjects pulse rate is not in the target range after 2 minutes, then the loading wattage was adjusted accordingly by 25 watts for the remainder of the test. At the end of 6 minutes, pulse rate and loading wattage were noted down from monitor. After 6 minutes of exercise, the subjects were asked to lie down. Cardiorespiratory parameters like pulse rate, respiratory rate, blood pressure were immediately recorded. Subjects were allowed to take rest for 15 minutes. Cardio respiratory parameters were recorded 15 minutes after exercises. Aerobic power was determined from the heart rate noted at the end of 6 minutes cycling by using Astrand –Rhyming nomogram.

RESULTS

Statistical analysis was done by using ANOVA repeated measures and Boneferoni multiple comparison test. Table 1, shows the comparison of cardiorespiratory parameters. It showed a statistically significance with p value less than 0.001. Table 2 shows the mean aerobic power or VO_{2max} (L/min) of male & female students.

Table 1: Comparison of cardiorespiratory parameters.

Variables	Rest		Immediately after exercise		15 minutes after exercises		ANOVA repeated measures F value	p value	Boneferoni multiple comparison test result
	Mean	SD	Mean	SD	Mean	SD			
Pulse Rate	76.000	6.187	142.600	8.418	88.867	6.897	922.72	<0.001	1 Vs 2 Vs 3
Respiratory Rate	13.467	1.525	27.100	4.421	15.200	2.605	255.45	<0.001	1 Vs 2 Vs 3
Systolic Blood Pressure	123.667	8.899	176.667	10.203	136.867	4.629	469.19	<0.001	1 Vs 2 Vs 3
Diastolic Blood Pressure	74.000	5.632	61.667	7.466	63.333	7.112	109.22	<0.001	1 Vs 2, 3

Table 2: Aerobic power.

Variables	Mean	SD
Vo_{2max} (L/min) Male	2.973	0.245
Vo_{2max} (L/min) Female	2.665	0.305

DISCUSSION

There was statistically significant increase in heart rate immediately after the exercise over the pre exercise value ($p<0.001$). Also there was persistent tachycardia 15 minutes after exercises. Tachycardia in exercise occurs due to following mechanisms: Increased sympathetic discharge, muscle heart reflex, increased release of catecholamines and thermogenic stimulation.[2-4] There was statistically significant increase in systolic blood pressure immediately after the exercise over the pre exercise value ($p<0.001$).

Chapman CB et al conducted a study regarding stroke volume and cardiac output have shown that the stroke volume continue to increase at higher levels of exercise.[5] Other investigators found that the stroke volume after increasing promptly with low level of exertion reaches a plateau and does not increase progressively as exertion becomes more intense for untrained subjects.[6,7] Other researchers found that plateau in stroke volume may not occur for trained subjects.[8-10] The result discussed earlier regarding blood pressure states that the systolic blood pressure always increases in exercise proportionate to increase in cardiac output.[11] This occurs due to sympathetic induced cardio-accleration.

There was statistically significant decrease in diastolic blood pressure immediately after exercise over the pre exercise value ($p<0.001$). The diastolic blood pressure decreases with moderate exercise, which could be due to sympathetic cholinergic vasodilatation of skeletal blood vessels, metabolic vasodilatation and thermogenic vasodilatation leads to decreased peripheral resistance.[11]

There was statistically significant increases in respiratory rate immediately after the exercise over the pre-exercise value ($p<0.001$). The respiratory rate increases with exercise, which could be due to neural mechanism, chemical mechanism and thermogenic mechanism.[12-16] VO_{2max} can be a limiting factor for individual capacity to do prolonged muscular work.[17]So the determination of aerobic power or VO_2 max gives an idea of the capacity and regulation of O_2 transporting system.

Jackson AS et al suggests that VO_{2max} or aerobic power increases during childhood and reaches a peak during early adulthood, after that a gradual and steady decline take place with the increasing age.[18,19]

VO_{2max} varies greatly between individual, genetics play a major role.[20,21] Training in aerobic exercise may improve VO_{2max}. Resistance training alone does not increases VO_{2max}.[22,23]

CONCLUSION

Aerobic power or VO_{2max} or physical work capacity which involves a full functional support from cardiorespiratory and metabolic pathways is an appropriate test to study cardiopulmonary fitness. Implication: Astrand 6 minutes cycle test can be used for screening measures before joining in a job or sports training where physical fitness is needed.

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REFERENCES

1. Wasserman K, Hansen JE, Sue JY, Casaburi R, Whipp BJ. Principles of Exercise Testing and Interpretation 3rd edition.
2. Saper CBC. Convergence of autonomic and limbic connection in the insular cortex of the rat. J Comp Neural. 1982;210(2):163-73.
3. Fagraeus L, Linnarsson D. Autonomic origin of Heart rate fluctuations at the onset of muscular exercise. Journal of Applied physiology. 1976;40(5):679-82.
4. McCloskey DI, Mitchell JH. Reflexes cardiovascular and respiratory originating from exercising muscle. J. Physiol. 1972;224(1):173-86.
5. Chapman CB, Fisher JN and Sproule BJ. Behaviour of stroke volume at rest and during exercise in human beings. J. Clin. Inves. 1960;39(8):1208-13.
6. Plotnick GD, Becker LC, Fisher ML, Gerstenblith G, Renlund DG, Fleg JL et al. Use of Frant starling mechanism during sub maximal versus maximal upright exercise. Am J. Physiol. 1986;251(6Pt 2):H1101-5.
7. Thadani U, Parker Jo. Haemodynamics at rest and during supine and sitting bicycle exercise in normal subjects. AM . Cardiol. 1978;41:52-9.
8. Gledwill N, Cox D, Jamnik R. Endurance athlete's stroke volume does not plateau major advantage is diastolic function". Med Sci Sports Exer. 1994;26:1116-21.
9. Stickland MK, Welsh RC, Petersen SR, Tyberg JV, Andersons WD, Jones RL, et al. Does fitness level modulate the Cardiovasular hecomodynamic

response to exercise of Apool. Physiol. 2006;100:1895-901.
10. Zhou, B, Conlee RK, Jensan R, Fellingham GW, Georges JD and Fisher AG. Stroke volume does not plateau during graded exercise in elite male distance runners. Med. Sci. Sports Exer. 2001;33:1849-54.
11. Thompson WR. ACSM'S Guideline's for exercise Testing and Prescription. 8th edition. 2010.
12. Krogh A, Lindhard J. The regulation of respiration and circulation during the initial stages of muscular work Journal of physiol (Lond). 1913;47(1-2):112-36.
13. Comroe JHJR, Schmidt CF. The hyperpnea of muscular exercise. Physiol Rev. 1943;138:536-47.
14. Grodins FS. Analysis of factors concerned in regulation of breathing in exercise. Physiol. Rev. 1950;30,220.
15. Bannister RG, Cunningham DFC. The effects on the respiration and performance during exercise of adding oxygen to the inspired air. J. Physiol (Lond). 1954;125(1):118-37.
16. Filley GF, Gregoire F, Wright GW. Alveolar and arterial O2 tension and the significance of the alveolar – arterial oxygen tension difference in normal men. Journal Clin – Invest. 1954;33(4):517-29.
17. Saltin B, Rowell LB. Functional adaptations to physical activity and inactivity. Federation Proceeding. 1980;39(5):1506-13.
18. Jackson AS, Beard EF, Wier LT, Ross RM, Stuteville JE, Blair SN. Changes in aerobic power of men, ages 25-70 yr. Med Sci sports Exercise. 1995;27(1):113-20.
19. Jackson AS, Wier LT, Ayers GW, Beard EF, Stutevile JE, Blair SN. Changes in aerobic power of women, ages 20-64 yrs. Med Sci Sports Exercise. 1996;28(7):884-91.
20. Saltin B, Nazar K, Costill DL, Stein E, Jansson E, Essen B, Golnick D. The Nature of the training response; peripheral and central adaptations of one legged exercise. Acta Physiol Scand. 1976;96(3):289-305.
21. Green HJ, Jones S, Balt Burnett M, Farrance B, Ranney D. Adaptations in muscle metabolism to prolonged voluntary exercise and training. J Appl Physiol. 1995;78(1):138-45.
22. Kraemer WJ, Duncan ND, Volek JS. Resistance training and elite athletes: adaptations and program considerations. J Orthop Sports Phys Ther. 1998;28(2);110-9.
23. Kraemer WJ, Patton JF, Gordon SE, Harman EA, Deschenes MR, Reynolds K, et al. Compatibility of high intensity strength and endurance training on hormonal and skeletal muscle adaptation. J Appl Physiol. 1995;78(3):976-89.

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